Published in final edited form as:

J Child Psychol Psychiatry. 2020 October ; 61(10): 1092–1103. doi:10.1111/jcpp.13303.

Longitudinal sleep problem trajectories are associated with multiple impairments in child well-being

Ariel A. Williamson^{1,2,3}, Jodi A. Mindell^{1,3,4}, Harriet Hiscock^{5,6,7}, Jon Quach^{8,9}

¹Division of Pulmonary Medicine, Sleep Center, Children's Hospital of Philadelphia, Philadelphia, PA, USA;

²Department of Child & Adolescent Psychiatry & Behavioral Sciences, Children's Hospital of Philadelphia, Philadelphia, PA, USA;

³Department of Psychiatry, Perelman School of Medicine, University of Pennsylvania, Philadelphia, PA, USA;

⁴Department of Psychology, Saint Joseph's University, Philadelphia, PA, USA;

⁵Health Services Research Unit, Royal Children's Hospital, Melbourne, Vic., Australia;

⁶Centre for Community Child Health, Murdoch Children's Research Institute, Parkville, Vic., Australia;

⁷Department of Pediatrics, University of Melbourne, Melbourne, Vic., Australia;

⁸Melbourne Graduate School of Education, University of Melbourne, Carlton, Vic., Australia;

⁹Policy, Equity and Translation, Murdoch Children's Research Institute, Parkville, Vic., Australia

Abstract

Background: This study examined whether distinct sleep problem trajectories from infancy through middle childhood were associated with multiple aspects of child well-being at ages 10–11 years.

Methods: Data were from the first six waves of the Longitudinal Study of Australian Children – Birth Cohort (5,107 children recruited at birth). Caregivers reported on child sleep problems at each time point. A combination of caregiver-reported, teacher-reported and child-completed tasks were used to index child well-being outcomes at ages 10–11 years including emotional/behavioural functioning (internalizing and externalizing symptoms; self-control), health-related quality of life, cognitive skills and academic achievement.

Correspondence: Ariel A. Williamson, Children's Hospital of Philadelphia, 2716 South Street, Philadelphia, PA 19146, USA; williamsoa@email.chop.edu.

Conflict of interest statement: No conflicts declared.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Ethical approval

Written informed consent for study participation was obtained from the child's primary caregiver/legal guardian. The study was approved by the Australian Institute of Family Studies Ethics Committee and funded by the Australian federal government. No financial compensation was provided to participants.

Results: Latent class analysis identified five distinct sleep problem trajectories over time: persistent sleep problems through middle childhood (7.7% of the sample), limited infant/preschool sleep problems (9.0%), increased middle childhood sleep problems (17.0%), mild sleep problems over time (14.4%) and no sleep problems (51.9%). Compared to those with no sleep problems, children with persistent sleep problems had the greatest impairments across all outcomes except cognitive skills (perceptual reasoning), with moderate to large effect sizes. Children with increased middle childhood sleep problems similarly experienced greater internalizing and externalizing symptoms and worse quality of life, but few academic impairments. Both the limited infant/preschool sleep problems and mild increases over time trajectories also showed internalizing concerns and worse caregiver-reported quality of life, although effects were smaller than the other sleep trajectories.

Conclusions: The linkages between sleep problems and negative child outcomes across domains underscore the importance of early identification and targeted intervention to address sleep problems and promote child well-being.

Keywords

Academic; cognitive; longitudinal studies; sleep; quality of life; well-being

Introduction

Up to 40% of children will experience symptoms of behavioural sleep problems, such as difficulty falling or staying asleep (Mindell, Kuhn, Lewin, Meltzer, & Sadeh, 2006; Sadeh, Mindell, Luedtke, & Wiegand, 2009). Behavioural sleep problems often co-occur with behavioural health and neurodevelopmental conditions (Tietze et al., 2012; Van Dyk, Becker, & Byars, 2019) and are associated with diminished child well-being (e.g. psychological, social, cognitive/academic and physical health functioning; Moore et al., 2011). Specifically, behavioural sleep problems have been linked to increased emotional and behavioural concerns (Gregory & O'Connor, 2002; Wang et al., 2016; Williams, Berthelsen, Walker, & Nicholson, 2017), impaired cognitive and academic performance (Bub, Buckhalt, & El-Sheikh, 2011; Hoyniak et al., 2019; Williams, Nicholson, Walker, & Berthelsen, 2016) and poor health-related quality of life (Combs et al., 2016).

Although there are a number of previous longitudinal studies examining child sleep and well-being, there are several salient gaps in this research. For example, few studies have examined the continuity of sleep concerns and their association with developmental outcomes from infancy, when behavioural sleep problems are the most prevalent (Mindell et al., 2006; Williamson, Mindell, Hiscock, & Quach, 2019a), through the middle childhood. One study found that caregiver-reported child behavioural sleep problems at age 4 years predicted emotional and behavioural concerns at age 15 years (Gregory & O'Connor, 2002), but sleep problems in infancy and toddlerhood were not assessed. Other studies have examined problematic early childhood sleep patterns, such as actigraphy-derived delayed sleep timing (Hoyniak et al., 2019) or caregiver-reported child night awakenings and sleep duration (Kocevska et al., 2017; Touchette et al., 2007), with subsequent cognitive development, but outcome assessments did not extend beyond age 7 years. More research is needed that assesses the impact of sleep problems from infancy through middle childhood,

particularly as the first 10–11 years of life is a period of important child development, with the acquisition of foundational psychosocial and cognitive/academic skills and the transition to a formal school setting.

In addition, few previous longitudinal studies have examined whether distinct profiles, or classes, of sleep problems are differentially linked to child outcomes. An increasing number of studies have used latent growth curve modelling to identify individual trajectories of caregiver-reported child sleep problems (Bub et al., 2011; Friedman et al., 2009) or actigraphy-derived sleep patterns (El-Sheikh, Bub, Kelly, & Buckhalt, 2013; Hoyniak et al., 2019) and their association with child outcomes longitudinally. Whereas latent growth curve models can robustly model within- and between-person change trajectories (Tasca & Gallop, 2009), latent profile (continuous data) or class (categorical data) analysis can identify whether these longitudinal change trajectories can be categorized into subgroups (Lanza & Cooper, 2016). Very few paediatric sleep studies have applied this analytic approach, and those that do have focused primarily on problematic sleep patterns, such as quantified caregiver-reported child short sleep duration or night awakenings, instead of broad caregiver-identified child sleep problems. For instance, in a sample of preschoolers followed from ages 2 to 6 years, five different caregiver-reported child night-time sleep trajectories (Plancoulaine et al., 2018) and two different night awakening trajectories emerged (Reynaud et al., 2016). Children belonging to the frequent awakenings trajectory had increased emotional and behavioural concerns (Reynaud et al., 2018). Another study of young children found four sleep duration profiles, with those in the short sleeping profile showing diminished neurodevelopment at age 2 years (Smithson et al., 2018).

While examining problematic sleep patterns is important, it is also necessary to examine caregiver-identified behavioural child sleep problems, particularly as caregivers are typically responsible for seeking associated sleep treatment. Furthermore, some children with behavioural sleep concerns may not view their sleep behaviours as being problematic (e.g. child difficulty sleeping independently may be concerning to the caregiver but not the child). Only two previous studies have examined profiles of caregiver-identified behavioural sleep problems. A study of nearly 2,000 children followed longitudinally from ages 5 to 17 years found a profile of ‘normal sleepers’ (89.4% of the sample) without any sleep concerns over time and ‘troubled sleepers’ (10.6%) with persistent caregiver-reported sleep problems, who also demonstrated poorer emotional and behavioural functioning at age 17 years. In our study using latent class analysis (LCA) to identify caregiver-reported behavioural sleep problems from ages 0–1 years through ages 10–11 years, we found five distinct trajectories (Figure 1): (a) persistent sleep problems through middle childhood (b) limited infant/preschool sleep problems, (c) increased middle childhood sleep problems, (d) mild sleep problems over time and (e) no sleep problems (Williamson, Mindell, Hiscock, & Quach, 2019b). However, we have not yet examined whether these trajectories are differentially associated with child well-being outcomes.

Building on this research, the present study aimed to examine whether these five previously identified, distinct behavioural sleep problem trajectories are associated with domains of child well-being at 10–11 years: emotional/behavioural functioning (internalizing and externalizing symptoms; self-control), health-related quality of life, cognitive skills and

academic achievement. This study extends noted gaps in previous longitudinal research in several ways. First, we assessed child sleep problems from infancy through middle childhood, which captures a key period of development and the first major school transition. Second, we identified specific subgroups of sleep problem trajectories using LCA. Third, we focused on caregiver-reported sleep problems, given the importance of caregiver report for behavioural sleep disorder diagnosis (American Academy of Sleep Medicine, 2014) and treatment seeking in childhood. Finally, whereas previous studies have examined only one or two domains of child well-being, we assessed multiple aspects of child well-being (Moore et al., 2011), which allows for the comparison of sleep problem impacts across outcomes and can inform targeted sleep and behaviour interventions. We hypothesized that children belonging to the persistent sleep problems trajectory would exhibit the poorest child well-being outcomes. We also hypothesized that children belonging to the increased middle childhood sleep problems trajectory would show impairments in child well-being, given that children in this trajectory showed an increase in sleep problems around the same time as the ages 10–11 year outcomes assessment occurred.

Method

Study design and participants

Data were drawn from the first 6 waves of the Growing up in Australia: The Longitudinal Study of Australian Children (LSAC)—Birth Cohort (B-cohort). Detailed information about the study design and methods has been provided elsewhere (Soloff, Lawrence, & Johnstone, 2005). The B-cohort includes 5,107 infants aged 0–1 years who were enrolled in 2004 (Wave 1; Table 1). Follow-up waves occurred biennially. A total of 3,764 (73.7%) child participants remained in the study at Wave 6 (age 10–11 years). The final analytic sample for this study was 4,517 participants (including those children for whom complete data were collected at least four time points). Children with less highly educated caregivers and children from non-English speaking backgrounds had marginally increased study attrition (Norton & Monahan, 2015).

Procedure

At each data collection wave, a face-to-face interview was conducted with the primary caregiver (usually the mother) in the family home (Australian Government Department of Families, 2011). Teachers of participating children were also asked to complete a survey sent by mail.

Measures

Sleep problem trajectories (birth to ages 10–11 years).—In a previous paper, we used latent class analysis in Mplus to derive five sleep problem trajectories based on a caregiver-reported child sleep problem item at each time point (Williamson et al., 2019b). Caregivers rated *How much is your child's sleeping pattern or habits a problem for you?* as *a large problem, a moderate problem, a small problem, no problem at all* or *not sure/don't know*. Responses were dichotomized according to extensive previous research cross-cultural and intervention research (Hiscock et al., 2019; Mindell et al., 2011; Quach, Hiscock, Ukoumunne, & Wake, 2011; Quach, Nguyen, O'Connor, & Wake, 2017; Sadeh et al., 2009;

Sadeh, Mindell, & Rivera, 2011), with a sleep problem defined as those who had a *moderate* or *large problem*. *Not sure/don't know* responses were coded as missing. In identifying these trajectories, we covaried for child sleep behaviours reported at each time point by the primary caregiver (*difficulty getting off to sleep at night*; *not happy to sleep alone*; and *waking during the night*). Although the prevalence of these child sleep behaviours varied over development, each behaviour was strongly associated with the presence of a caregiver-reported child sleep problem at each age in this sample (odds ratios ranging from 3.10 to 17.78, $p < .001$; Williamson et al., 2019a).

Figure 1 shows the proportion of the sample at each age (x -axis) in each trajectory (y -axis), with the distribution of the sample for each trajectory. Spanning ages 0–1 to 10–11 years, 51.9% of children were in the ‘no sleep problems’ trajectory. Another 14.4% showed ‘mild sleep problems over time,’ reflecting lower levels of sleep problems consistently across all timepoints. Nine per cent (9.0%) had ‘limited infant/preschool sleep problems.’ Seventeen per cent had ‘increased middle childhood sleep problems’ trajectory, with sleep problems increasing steadily from ages 4–5 to 10–11 years. A ‘persistent sleep problems through middle childhood’ trajectory captured children whose caregivers endorsed high levels of sleep problems over time (7.7%).

Child internalizing and externalizing concerns at ages 10–11 years.—The primary caregiver and teacher reported on child internalizing and externalizing concerns using the Strengths and Difficulties Questionnaire (SDQ). Internalizing symptoms were represented by the 5-item SDQ emotional problems subscale (e.g. many worries, often seems worried; often unhappy, downhearted or tearful), with possible scores ranging from 0 to 10. Externalizing symptoms were represented by 10 items from the SDQ conduct and hyperactivity/inattention subscales (e.g. often loses temper; often fights with other children or bullies them; restless, overactive, cannot sit still for long), with possible scores ranging from 0 to 20. Higher scores on these measures indicate greater emotional and behavioural concerns. The SDQ is a widely used measure for children aged 4–16 years with strong psychometric properties, including good internal consistency (caregiver report $\alpha = .63-.77$ and teacher report $\alpha = .74-.88$ for the subscales used in this study), strong stability, an established underlying factor structure and correspondence with child psychiatric diagnoses (Goodman, 2001; Stone, Otten, Engels, Vermulst, & Janssens, 2010). Caregiver and teacher interrater agreement correlations are .23–.41 for the emotional symptoms subscale, .27–.65 for the conduct problems subscale, and .44–.61 for the hyperactivity/inattention subscale, supporting the multi-informant use of the SDQ (Stone et al., 2010).

Self-control at ages 10–11 years.—The primary caregiver reported on child self-control using seven items from the Social Skills Improvement Rating System (Gresham, Elliott, & Kettler, 2010). Higher scores indicate increased child self-control. Psychometric research shows strong internal consistency ($\alpha = .84$) for this subscale and convergence with similar measures of prosocial behaviours (Gresham et al., 2010; Gresham, Elliott, Vance, & Cook, 2011).

Quality of life at ages 10–11 years.—The primary caregiver reported on child quality of life using the Pediatric Quality of Life Inventory (PedsQL) Version 4.0, which is a 23-

item questionnaire for children aged 2–18 years (Varni, Limbers, & Burwinkle, 2007). Fifteen items are summed to yield a Psychosocial Health summary score that reflects child quality of life with regard to emotional, social and school functioning, while the remaining eight items are summed to generate a Physical Health summary score. Summary scores are transformed to a 0–100 scale with increased scores representing better quality of life. In samples of both children with chronic illnesses and healthy controls (Varni, Burwinkle, Seid, & Skarr, 2003; Varni et al., 2007), the PedsQL has shown good psychometric properties, including strong internal consistency ($\alpha = .88$ for the caregiver-reported Psychosocial Health and Physical Health scores) and construct validity.

Cognitive and academic skills at ages 10–11 years.—Four aspects of child cognitive and academic skills were assessed. First, *nonverbal (perceptual reasoning) skills* were assessed via performance the Wechsler Intelligence Scale for Children (WISC-IV) matrix reasoning subtest, which is a reliable ($\alpha = .89$), valid and norm-referenced measure of child perceptual reasoning (Wechsler, 2003). The matrix reasoning subtest has a mean score of 10 with a standard deviation of 3. Additional psychometric information is available elsewhere (Wechsler, 2003).

Second, *academic competencies in language/literacy and mathematics* were indexed using two subscales from the teacher-reported Academic Rating Scale (ARS), which is a 20-item measure drawn from the Early Childhood Longitudinal Study (ECLS; (Rock & Pollack, 2002). The Language and Literacy scale contains 11 items, while the Mathematical Thinking subscale contains nine items. Each subscale has a possible range of 1–5, with higher scores reflecting higher levels of academic competency. Rasch models were applied to estimate ARS scores in the original measurement development and validation study (Rock & Pollack, 2002), which provided evidence of very strong person reliability for the Rasch-based scores (.91 for Language and Literacy and .94 for Mathematical Thinking).

Third, *academic achievement* was defined using children's scores from the Australian National Assessment Program—Literacy and Numeracy (NAPLAN) exam (Australian Curriculum, 2018). NAPLAN tests are designed each year by the Australian Curriculum, Assessment and Reporting Authority to measure academic progress according to the Australian Curriculum (Australian Curriculum, 2018). Students complete this standardized assessment in Years 3, 5, 7 and 9. Academic scores for Year 5 (ages 10–11 years) were available in the domains of mathematics, reading, sentence comprehension, writing and spelling. We computed a mean score across domains to reflect broad academic achievement, with higher scores indicating higher achievement. In a technical report, which contains details about this standardized assessment, the NAPLAN showed moderate correspondence ($r = .41-.64$) with teacher-rated ARS scores in the LSAC study (Daraganova, Edwards, & Sipthorp, 2013).

Finally, *classroom learning* was defined by six teacher-reported items from the Approach to Learning Social Rating Scale, which was developed by the ECLS-K (Rock & Pollack, 2002). Items were designed to assess various aspects of a child's approach to learning, such as organization, working independently and task completion. The possible score range was 1–6, with higher scores indicating better learning-related behaviours. Split half reliability in

the validation study for this measure was high (.89), with evidence of good validity through moderate convergence with other teacher-rated child behaviour measures (Rock & Pollack, 2002).

Confounders.—Confounders included Wave 1 child age and Wave 6 family socioeconomic position (SEP). Family SEP is a composite LSAC measures derived from standardized scores of combined annual household income, parental education and parental occupation (Blakemore, Strazdins, & Gibbings, 2009). SEP is divided into quintiles. As proportions of children in each trajectory varied only marginally by SEP quintile, we elected to adjust, rather than stratify, for SEP quintile to account for any residual confounding.

We additionally covaried for maternally and paternally reported family risk index scores, as our previous research demonstrated that these indexes, which were assessed at child age 0–1 years, predicted the sleep trajectories used in this study (Williamson et al., 2019b). These family risk scores were generated separately by reporter, with each risk item dichotomized and averaged to generate a risk index (range 0–1, with 1 being positive for all items). Each family risk index contained a caregiver rating of marital hostility, clinically significant psychological distress as measured by the Kessler-6 (Kessler et al., 2002), and exposure to stressful life events. The mother-reported risk index also contained a dichotomous (yes/no) item on whether she had felt depressed over the last 2 weeks. Higher risk scores indicate greater family-level risk at child age 0–1 years. Details about the psychometric properties of these variables and the index scores are provided elsewhere (Hancock, Christensen, & Zubrick, 2018; Williamson et al., 2019b).

Statistical analysis

We used survey methods in all analyses to account for the unequal probability related to participant selection and attrition and the multi-stage, clustered sampling design. All analyses were conducted in Stata version 15.0. Psychosocial outcomes at ages 10–11 years were converted to z-scores to facilitate comparison across sleep problem trajectories and for presentation as effect sizes relative to the whole sample's standard deviation. Associations between the sleep trajectories and child well-being were determined using unadjusted and adjusted linear regression to estimate the mean differences between trajectories, with the 'no sleep problems' sleep trajectory as the reference group. Only adjusted regressions are presented because estimates attenuated minimally on including the a priori confounders.

Results

Demographic information

Table 1 shows the demographic information when the birth cohort sample was recruited at child ages 0–1 years. There were similar proportions of girls and boys (51.1% boys). Most of the primary caregivers were mothers (96.1%). The majority of children were from two-caregiver families (90.6%) and spoke English as the primary language at home (85.6%). Over half had a caregiver who had completed at least high school (68.3% of mothers; 59.8% of fathers).

Associations between sleep problem trajectories and well-being

The associations between the sleep problem trajectories and child well-being are shown in Figures 2 and 3 and Table S1, expressed as effect sizes (ES) indicating the adjusted mean difference between each sleep problem trajectory and the ‘no sleep problem’ trajectory used as the reference group. Across outcomes, with the exception of child nonverbal reasoning, children in the ‘persistent sleep problems through middle childhood’ trajectory showed the poorest functioning, with effect sizes for the mean differences compared to the no sleep problem group in the moderate to large range.

Child internalizing and externalizing concerns.

Children in the ‘persistent sleep problems’ trajectory showed moderate teacher-reported internalizing (ES = -0.65 , 95% CI: -0.87 to -0.43 , $p < .001$) and externalizing concerns (ES = -0.40 , 95% CI: -0.58 to -0.21 , $p < .001$) and large caregiver-reported internalizing (ES = -0.75 , 95% CI: -0.92 to -0.57 , $p < .001$) and externalizing concerns (ES = -0.70 , 95% CI: -0.86 to -0.53 , $p < .001$) relative to those with no sleep problems. Children in the ‘increased middle childhood sleep problems’ trajectory similarly showed greater caregiver- and teacher-rated internalizing and externalizing symptoms, with small to moderate effect sizes (caregiver ES for both = -0.61 , 95% CI: -0.76 to -0.39 , 95% CI: -0.53 to -0.15 , $p < .001$). Children with ‘limited infant/preschool sleep problems’ only showed small impairments in teacher-rated internalizing symptoms (ES = -0.12 , 95% CI: -0.23 to -0.01 , $p < .05$), whereas children in the ‘mild sleep problems over time’ trajectory showed small impairments in caregiver-rated internalizing symptoms (ES = -0.19 , 95% CI: -0.30 to -0.08 , $p < .001$).

Self-control.

Children following the ‘persistent sleep problems’ and ‘increased middle childhood sleep problems’ trajectories showed moderate impairments in caregiver-reported self-control compared to children without sleep problems (ES for both = -0.37 , 95% CI: -0.52 to -0.21 , $p < .001$). Neither the ‘limited infant/preschool sleep problems’ nor the ‘mild sleep problems over time’ trajectories evidenced significant impairments in self-control.

Quality of life.

Children in all of the trajectories showed significantly worse caregiver-reported psychosocial and health-related quality of life compared to those in the ‘no sleep problems’ group. Effect sizes were largest for those in the ‘persistent sleep problems group’ (ES range = -0.78 to -0.90 , 95% CI: -1.06 to -0.56 , $p < .001$), followed by those in the ‘increased middle childhood sleep problems’ trajectory (ES range = -0.33 to -0.75 , 95% CI: -0.88 to -0.19 , $p < .001$). Children in the ‘limited infant/preschool sleep problems’ (ES range = -0.12 to -0.13 , 95% CI: -0.23 to -0.02 , $p < .05$) and ‘mild sleep problems over time’ (ES range = -0.17 to -0.20 , 95% CI: -0.32 to -0.05 , $p < .01$) trajectories showed small quality of life impairments.

Cognitive and academic skills.

No trajectories showed significant impairments in nonverbal reasoning compared to children without sleep problems. However, children with persistent sleep problems evidenced moderate teacher-rated language/literacy and mathematical thinking impairments ($ES = -0.41$ for both outcomes, 95% CI: -0.60 to -0.23 , $p < .001$). Whereas children in the 'increased middle childhood sleep problems' and 'limited infant/preschool sleep problems' showed no significant differences in academic competencies, those in the 'mild sleep problems' trajectory evidenced small impairments in these outcomes (ES range = -0.14 to -0.17 , 95% CI: -0.31 to -0.004 , $p < .05$).

Findings for academic achievement on standardized national testing followed a similar pattern, with children who had 'persistent sleep problems' showing lower achievement scores, with a small effect size ($ES = -0.29$, 95% CI: -0.46 to -0.12 , $p < .001$). No significant differences were found for children in the 'increased middle childhood sleep problems' and 'limited infant/preschool sleep problems' trajectories. Those with mild sleep problems did show very small, yet significant, impairments ($ES = -0.14$, 95% CI: -0.27 to -0.02 , $p = .03$).

Teacher-rated approach to learning also varied by sleep trajectory. The 'persistent sleep problems' group showed moderate impairments in learning-related behaviours ($ES = -0.42$, 95% CI: -0.59 to -0.25 , $p < .001$), while the 'increased middle childhood sleep problems' showed small impairments ($ES = -0.26$, 95% CI: -0.41 to -0.12 , $p < .001$). No differences emerged for children with 'limited infant/preschool sleep problems' or for those with 'mild sleep problems.'

Discussion

Overall, this study found that caregiver-perceived behavioural sleep problems at any age, from birth to age 10–11 years, were associated with impairments in multiple domains of child well-being in middle childhood. These findings extend previous longitudinal research linking sleep and child outcomes. Previous studies were limited by a lack of attention to the important period between infancy and middle childhood and a focus on problematic sleep patterns (e.g. quantified sleep duration or awakenings) rather than caregiver-identified child sleep problems, which are important given the role of caregivers in diagnosing and seeking treatment for these concerns. Additionally, few studies have identified latent classes, or subgroups, of sleep problems and examined these groups in relation to domains of child well-being. Children with persistent sleep problems evidenced the greatest impairments relative to those without sleep problems, with the mean difference effect sizes in the moderate to large range. These impairments included greater caregiver- and teacher-reported internalizing and externalizing psychopathology symptoms, the poorest quality of life, the worst self-control and the most impaired language/literacy and mathematics competencies, academic achievement and classroom behaviours. Children with increased sleep problems in middle childhood had moderate impairments in psychosocial domains that were similar to those with persistent sleep problems (psychopathology; quality of life; self-control), but this group had few academic and cognitive impairments. Children with limited infant/preschool sleep problems similarly had few academic and cognitive impairments, but did evidence

teacher-reported internalizing symptoms and poorer caregiver-reported quality of life. Interestingly, children who had ‘mild sleep problems over time’ also showed impairments across many domains, albeit with smaller effect sizes.

While these findings are consistent with many studies showing associations between childhood sleep problems and poor outcomes (Combs et al., 2016; Dewald, Meijer, Oort, Kerkhof, & Bogels, 2010; Gregory & O’Connor, 2002; Wang et al., 2016), the findings of this study extend the literature by demonstrating how persistent child sleep problems measured in two-year increments longitudinally, rather than sleep problems at one or two age points, may be linked to child outcomes. In addition, study findings extend the literature by allowing for the comparison of the impact of sleep problems across different child outcomes. These study findings suggest that some aspects of child well-being may be more closely linked to sleep problems than others. Across sleep problem trajectories, effect sizes were the largest for associations between sleep problems and child emotional/behavioural concerns (internalizing and externalizing symptoms, self-control) and health-related quality of life. Although this finding warrants replication, it could be that child sleep problems are more proximally and/or strongly linked to emotional/behavioural concerns and other aspects of psychosocial functioning, including health-related quality of life, than to cognitive and academic outcomes. Indeed, neurobiological research indicates that sleep may play a causal role in emotional regulation and processing (Goldstein & Walker, 2014), both of which are critical for psychosocial development. In addition, intervention research has demonstrated that addressing behavioural sleep problems can yield concurrent emotional/behavioural, but not academic, improvements (Quach et al., 2011).

Specific to the children in the persistent sleep problems trajectory, poor sleep in the first 10 years of life may be particularly detrimental for both the acquisition and advancement of emotional and behavioural regulation skills. Diary studies (Kouros & El-Sheikh, 2015; Van Dyk, Thompson, & Nelson, 2016) and experimental sleep restriction research (Baum et al., 2014; Miller, Seifer, Crossin, & Lebourgeois, 2015) show that poor sleep is linked to short-term emotional and behavioural dysregulation, while longitudinal research shows that early sleep problems are associated with longer-term emotional and behavioural consequences (Gregory & O’Connor, 2002; Sivertsen et al., 2015). Persistent sleep problems resulting in both short- and longer-term impacts on child emotional/behavioural functioning could explain the larger mean difference effect sizes for impairments in these domains relative to those found in the other sleep problem trajectories. Bidirectional associations between sleep problems and emotional/behavioural concerns occurring daily (Kouros & El-Sheikh, 2015) and longitudinally (Quach, Nguyen, Williams, & Sciberras, 2018; Wang et al., 2016; Williams et al., 2017) could also explain these greater impairments compared to those with shorter-term concurrent sleep issues, such as those seen in the increased middle childhood sleep problems trajectory.

In addition, impairments in both sleep and emotional/behavioural functioning may cumulatively impact subsequent child classroom behaviours and, in turn, academic achievement (Williams et al., 2017; Williams et al., 2016). For example, despite having a pattern of increased middle childhood sleep problems, children on this trajectory did not show concurrent impairments in cognitive and academic performance (standardized testing

and teacher-rated academic achievement). The only impaired academic outcome for this group was teacher-rated approach to learning, which captures classroom learning-related behaviours such as attention and organization. Given the relatively recent onset and worsening of sleep problems for children belonging to this trajectory relative to the assessment of child outcomes, it is possible that sleep concerns have not yet begun to erode or even possibly do not affect academic achievement, but do impact classroom behaviours (e.g. organization, attention) and thus teacher perceptions of student behaviour, including emotional/behavioural concerns. Academic performance at age 10–11 years may be more dependent on child functioning longitudinally, including prior academic skill acquisition, and perhaps reflects the cumulative impact of sleep on performance, whereas classroom behaviours could represent the next-day impacts of poor sleep. This idea is in line with experimental sleep restriction research, which shows impaired attention in sleep-deprived youth (Beebe, Rose, & Amin, 2010). It could be that only children with persistent sleep problems experience impairments in standardized academic testing and teacher-rated achievement because their poor sleep has impacted classroom behaviour over a longer period of time, resulting in impaired learning and poor academic skills acquisition. Of note, however, studies have not examined whether caregiver-perceived child sleep problems such as difficulty falling or staying asleep are linked to next-day child functioning, which is an important future research direction.

It is also notable that no trajectories were associated with nonverbal perceptual reasoning. Cognitive functioning and performance on a particular task at one timepoint may be more attributable to other, perhaps less malleable factors, such as genetic heritability for perceptual skills. Sleep problems may also be differentially associated with cognitive skills. For instance, short sleep duration has been linked to perceptual reasoning deficits across studies (Astill, Van der Heijden, Van Ijzendoorn, & Van Someren, 2012; Gruber et al., 2010), but as previously noted research is limited on the extent to which other behavioural sleep problems such as paediatric insomnia symptoms are linked to cognitive functioning.

More research that identifies the sequence by which behavioural sleep problems impact different domains of child functioning is needed to better understand these findings as well as those related to children in the other sleep trajectories examined in this study. Given that child sleep problems are known to co-occur at a high rate with behavioural health and neurodevelopmental conditions (Tietze et al., 2012; Van Dyk et al., 2019), both of which impair multiple aspects of child functioning, children with sleep problems at any age in this study may represent those with diagnosed or subclinical psychopathology or neurodevelopmental differences. Especially in light of results suggesting middle childhood internalizing concerns for those in the limited infant/preschool and mild sleep problem trajectories, sleep problems could serve as a sign of subsequent anxiety or other internalizing disorders. Future research should examine whether sleep problems longitudinally predict child impairment over and above existing behavioural health and neurodevelopmental diagnoses. As noted earlier, it is also quite possible that psychosocial impairments predict sleep problems, with bidirectional linkages that should be examined in additional research (Quach et al., 2018; Wang et al., 2016).

Study findings have important implications for more comprehensively addressing child sleep problems. Sleep problems are highly prevalent in early childhood, impacting 20%–30% of infants, toddlers and preschoolers (Mindell et al., 2006). In this study, children on the trajectory characterized by early sleep problems that remitted after preschool still showed small impairments in aspects of child well-being, particularly caregiver-reported child quality of life and teacher-reported internalizing symptoms. These findings underscore the importance of identifying and treating child sleep problems early in development, particularly to avoid having these sleep concerns persist into middle childhood, when they are associated with more deleterious impacts on child well-being.

In addition, the persistence of child sleep problems and the significant and cross-domain impairments seen in middle childhood indicate that screening for sleep problems consistently over development is necessary, especially to target children who experience persistent sleep problems longitudinally. Additional research is needed on the child and family characteristics of those who evidence persistent sleep problems, as this could help to direct screening efforts. However, even children whose caregivers-reported ‘mild sleep problems’ over time appear to be at-risk for poor outcomes, as children following this trajectory evidenced small psychosocial and academic impairments. Although this study cannot answer whether minor, early or persistent sleep problems represent a marker for the onset of behavioural health or neurodevelopmental conditions, findings support consistently integrating questions about sleep into routine developmental screenings in school and primary care contexts. As screening for social–emotional and behavioural health concerns increasingly occurs in these settings (Dowdy et al., 2015; Essex et al., 2009; Wissow et al., 2013), better incorporating sleep problems in these screenings could help to identify children who are at-risk for later impairments in other domains.

Interventions targeting symptoms of both sleep problems and psychopathology are needed to identify whether addressing these often comorbid concerns can prevent their progression and impact on child well-being. Some intervention research has targeted both sleep and anxiety disorders, with mixed findings (Alfano, 2018). A recent pilot trial found that an integrated sleep and anxiety treatment was feasible and acceptable for anxious youth, with similar sleep benefits for children randomized to the combined treatment or a standard cognitive behavioural therapy condition (Clementi & Alfano, 2020). Concurrently treating insomnia and depressed mood in adolescents has also yielded positive results (Clarke et al., 2015). Additionally, an open trial of caregiver training enhanced with behavioural sleep strategies was associated with large improvements in disruptive behaviours (Nelson, Van Dyk, McGinnis, Nguyen, & Long, 2016). Future research should examine whether these approaches are feasible for children with different severities of sleep problems and comorbid conditions, and on methods for sequencing these treatment components.

Limitations of this study include an Australian sample that may not be generalizable to children of different racial/ethnic backgrounds or living in different cultural contexts. We covaried for child age, family socioeconomic factors and family-level risks assessed at birth, including caregiver stress exposure and mood, but there are many other factors that may contribute to or account for the associations found between sleep problems and child well-being. Factors that are more proximally associated with child sleep and functioning in

middle childhood, such as caregiver–child interactions (Kelly & El-Sheikh, 2013) and teacher–student relationships (Holdaway & Becker, 2018), as well as underlying factors including child temperament (Cremone et al., 2018) and genetic predispositions, should also be examined in subsequent research studies. As some of the outcomes for the persistent sleep problems group had 95% confidence intervals that overlapped with other groups, it is possible that those with persistent sleep problems may not necessary have the poorest outcomes. However, the findings do indicate that persistent sleep problems are associated with the poorest outcomes compared to those without sleep problems, even if they are similar to other sleep problem trajectories.

This study did not utilize objective measures of child sleep, such as actigraphy, and did not assess child sleep duration or sleep time regularity or child-report of behavioural sleep problems, which can also influence outcomes. Dichotomizing sleep problems is common in population-based paediatric sleep research (Quach et al., 2011; Sadeh et al., 2011) and has been highly correlated with caregiver-reported problematic sleep behaviours (Williamson et al., 2019a). Nonetheless, this approach may miss nuanced differences in the nature of childhood sleep disturbances and does not substitute for sleep disorder diagnosis. Studies examining distinct profiles of paediatric sleep disorders, such as different subtypes of paediatric insomnia, should also assess whether such profiles differentially predict child outcomes. The reliance on caregiver-reported child sleep problems and some of the outcomes may contribute to greater associations between these variables. However, we did utilize a multi-informant approach, with several teacher-rated outcomes and objective ratings of child performance on tasks (nonverbal reasoning and academic achievement), which also showed significant associations with some sleep problem trajectories. Replicating and extending the examination of sleep problem trajectories into adolescence is necessary, particularly given evidence of sleep problem persistence and psychopathology symptoms in teenagers (Quach et al., 2018; Wang et al., 2016).

Conclusions

Sleep problem trajectories from infancy to 10–11 years were associated with impairments in multiple domains of child well-being. Children with persistent sleep problems had the poorest outcomes, with the strongest associations and largest mean effect sizes in the areas of child internalizing and externalizing symptoms and quality of life. Notably, impairments in child well-being were found across all sleep problems trajectories. The differences in outcomes based on the five distinct sleep trajectories provide evidence that future studies should focus on methods to consistently screen for child sleep concerns throughout development and implement interventions that can target child sleep problems and benefit broad child well-being.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgements

Eunice Kennedy Shriver National Institute of Child Health and Human Development (K23HD094905; A.A.W.); Sleep Research Society Foundation (A.A.W.); National Health and Medical Research Council (Practitioner Fellowship, 1136222; H.H.); Victorian Government's Operational Infrastructure Support Program (J.Q.). The authors have declared that they have no competing or potential conflicts of interest.

References

- Alfano CA (2018). (Re) conceptualizing sleep among children with anxiety disorders: Where to next? *Clinical Child and Family Psychology Review*, 21, 482–499. [PubMed: 30136070]
- American Academy of Sleep Medicine (2014). *International classification of sleep disorders—third edition (ICSD-3)*. Darien, IL: American Academy of Sleep Medicine.
- Astill RG, Van der Heijden KB, Van Ijzendoorn MH, & Van Someren EJ (2012). Sleep, cognition, and behavioral problems in school-age children: A century of research meta-analyzed. *Psychological Bulletin*, 138, 1109–1138. [PubMed: 22545685]
- Australian Curriculum, Assessment and Reporting Authority (2018). *National Assessment Program Test Development*. Available from: <https://www.nap.edu.au/about/test-development> [last accessed 11 May 2020].
- Australian Government Department of Families, Housing, Community Services and Indigenous Affairs (2011). *Growing up in Australia: The Longitudinal Study of Australian Children 2009–10 Annual Report*. Retrieved from Australia.
- Baum KT, Desai A, Field J, Miller LE, Rausch J, & Beebe DW (2014). Sleep restriction worsens mood and emotion regulation in adolescents. *Journal of Child Psychology and Psychiatry*, 55, 180–190. [PubMed: 24889207]
- Beebe DW, Rose D, & Amin R (2010). Attention, learning, and arousal of experimentally sleep-restricted adolescents in a simulated classroom. *Journal of Adolescent Health*, 47, 523–525. [PubMed: 20970088]
- Blakemore T, Strazdins L, & Gibbins J (2009). Measuring family socio-economic position. *Australian Social Policy Journal*, 8, 121.
- Bub KL, Buckhalt JA, & El-Sheikh M (2011). Children's sleep and cognitive performance: A cross-domain analysis of change over time. *Developmental Psychology*, 47, 1504. [PubMed: 21942668]
- Clarke G, McGlinchey EL, Hein K, Gullion CM, Dickerson JF, Leo MC, & Harvey AG (2015). Cognitive-behavioral treatment of insomnia and depression in adolescents: A pilot randomized trial. *Behavior Research and Therapy*, 69, 111–118.
- Clementi MA, & Alfano CA (2020). An integrated sleep and anxiety intervention for anxious children: A pilot randomized controlled trial. *Clinical Child Psychology and Psychiatry*. 10.1177/1359104520933936. [Epub ahead of print].
- Combs D, Goodwin JL, Quan SF, Morgan WJ, Shetty S, & Parthasarathy S (2016). Insomnia, health-related quality of life and health outcomes in children: A seven year longitudinal cohort. *Scientific Reports*, 6, 27921. [PubMed: 27295263]
- Cremone A, de Jong DM, Kurdziel LBF, Desrochers P, Sayer A, LeBourgeois MK, ... & McDermott JM (2018). Sleep tight, act right: negative affect, sleep and behavior problems during early childhood. *Child Development*, 89, e42–e59. [PubMed: 28129449]
- Daraganova G, Edwards B, & Siphthorp M (2013). Using National Assessment Program Literacy and Numeracy (NAPLAN) Data in the Longitudinal Study of Australian Children (LSAC). Department of Families, Housing, Community Services and Indigenous Affairs.
- Dewald JF, Meijer AM, Oort FJ, Kerkhof GA, & Bogels SM (2010). The influence of sleep quality, sleep duration and sleepiness on school performance in children and adolescents: A meta-analytic review. *Sleep Medicine Reviews*, 14, 179–189. [PubMed: 20093054]
- Dowdy E, Furlong M, Raines TC, Boverly B, Kauffman B, Kamphaus RW, ... & Murdock J (2015). Enhancing school-based mental health services with a preventive and promotive approach to universal screening for complete mental health. *Journal of Educational and Psychological Consultation*, 25, 178–197.

- El-Sheikh M, Bub KL, Kelly RJ, & Buckhalt JA (2013). Children's sleep and adjustment: A residualized change analysis. *Developmental Psychology*, 49, 1591. [PubMed: 23025266]
- Essex MJ, Kraemer HC, Slattery MJ, Burk LR, Boyce WT, Woodward HR, & Kupfer DJ (2009). Screening for childhood mental health problems: outcomes and early identification. *Journal of Child Psychology and Psychiatry*, 50, 562–570. [PubMed: 19432682]
- Friedman NP, Corley RP, Hewitt JK, & Wright KP Jr (2009). Individual differences in childhood sleep problems predict later cognitive executive control. *Sleep*, 32, 323–333. [PubMed: 19294952]
- Goldstein AN, & Walker MP (2014). The role of sleep in emotional brain function. *Annual Review of Clinical Psychology*, 10, 679–708.
- Goodman R (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry*, 40, 1337–1345. [PubMed: 11699809]
- Gregory AM, & O'Connor TG (2002). Sleep problems in childhood: a longitudinal study of developmental change and association with behavioral problems. *Journal of the American Academy of Child and Adolescent Psychiatry*, 41, 964–971. [PubMed: 12162632]
- Gresham FM, Elliott SN, & Kettler RJ (2010). Base rates of social skills acquisition/performance deficits, strengths, and problem behaviors: an analysis of the Social Skills Improvement System-Rating Scales. *Psychological Assessment*, 22, 809–815. [PubMed: 20804259]
- Gresham FM, Elliott SN, Vance MJ, & Cook CR (2011). Comparability of the Social Skills Rating System to the Social Skills Improvement System: Content and psychometric comparisons across elementary and secondary age levels. *School Psychology Quarterly*, 26, 27–44.
- Gruber R, Lavolette R, Deluca P, Monson E, Cornish K, & Carrier J (2010). Short sleep duration is associated with poor performance on IQ measures in healthy school-age children. *Sleep Medicine*, 11, 289–294. [PubMed: 20156702]
- Hancock KJ, Christensen D, & Zubrick SR (2018). Development and assessment of cumulative risk measures of family environment and parental investments in the longitudinal study of Australian children. *Social Indicators Research*, 37, 665–694.
- Hiscock H, Quach J, Paton K, Peat R, Gold L, Arnup S, ... & Wake M (2019). Impact of a behavioral sleep intervention on new school entrants' social emotional functioning and sleep: A translational randomized trial. *Behavioral Sleep Medicine*, 17, 698–712. [PubMed: 29757013]
- Holdaway AS, & Becker SP (2018). Children's sleep problems are associated with poorer student-teacher relationship quality. *Sleep Medicine*, 47, 100–105. [PubMed: 29783160]
- Hoyniak CP, Bates JE, Staples AD, Rudasill KM, Molfese DL, & Molfese VJ (2019). Child sleep and socioeconomic context in the development of cognitive abilities in early childhood. *Child Development*, 90, 1718–1737. [PubMed: 29484637]
- Kelly RJ, & El-Sheikh M (2013). Longitudinal relations between marital aggression and children's sleep: The role of emotional insecurity. *Journal of Family Psychology*, 27, 282–292. [PubMed: 23458697]
- Kessler RC, Andrews G, Colpe LJ, Hiripi E, Mroczek DK, Normand SL, ... & Zaslavsky AM (2002). Short screening scales to monitor population prevalences and trends in non-specific psychological distress. *Psychological Medicine*, 32, 959–976. [PubMed: 12214795]
- Kocevska D, Rijlaarsdam J, Ghassabian A, Jaddoe VW, Franco OH, Verhulst FC, & Tiemeier H (2017). Early childhood sleep patterns and cognitive development at age 6 years: The Generation R Study. *Journal of Pediatric Psychology*, 42, 260–268. [PubMed: 26803843]
- Kouros CD, & El-Sheikh M (2015). Daily mood and sleep: Reciprocal relations and links with adjustment problems. *Journal of Sleep Research*, 24, 24–31. [PubMed: 25212526]
- Lanza ST, & Cooper BR (2016). Latent class analysis for developmental research. *Child Development Perspectives*, 10, 59–64. [PubMed: 31844424]
- Miller AL, Seifer R, Crossin R, & Lebourgeois MK (2015). Toddler's self-regulation strategies in a challenge context are nap-dependent. *Journal of Sleep Research*, 24, 279–287. [PubMed: 25394169]
- Mindell JA, Du Mond CE, Sadeh A, Telofski LS, Kulkarni N, & Gunn E (2011). Efficacy of an internet-based intervention for infant and toddler sleep disturbances. *Sleep*, 34, 451–458. [PubMed: 21461323]

- Mindell JA, Kuhn B, Lewin DS, Meltzer LJ, & Sadeh A (2006). Behavioral treatment of bedtime problems and night wakings in infants and young children. *Sleep: Journal of Sleep and Sleep Disorders Research*, 29, 1263–1276.
- Moore K, Mbwana K, Theokas C, Lippman L, Bloch M, Vandivere S, & O'Hare W (2011). *Child well-being: An index based on data of individual children*. Washington, DC: Child Trends.
- Nelson TD, Van Dyk TR, McGinnis JC, Nguyen AV, & Long SK (2016). Brief sleep intervention to enhance behavioral parent training for noncompliance: Preliminary findings from a practice-based study. *Clinical Practice in Pediatric Psychology*, 4, 176–187.
- Norton A, & Monahan K (2015). *The Longitudinal Study of Australian Children: LSAC technical Paper No. 15, Wave 6 Weighting and Non-Response*
- Plancoulaine S, Reynaud E, Forhan A, Lioret S, Heude B, Charles M-A, ... & Charles M (2018). Night sleep duration trajectories and associated factors among preschool children from the EDEN cohort. *Sleep Medicine*, 48, 194–201. [PubMed: 30008301]
- Quach J, Hiscock H, Ukoumunne OC, & Wake M (2011). A brief sleep intervention improves outcomes in the school entry year: a randomized controlled trial. *Pediatrics*, 128, 692–701. [PubMed: 21890825]
- Quach J, Nguyen C, O'Connor M, & Wake M (2017). The cumulative effect of health adversities on children's later academic achievement. *Academic Pediatrics*, 17, 706–714. [PubMed: 28300654]
- Quach J, Nguyen CD, Williams KE, & Sciberras E (2018). Bidirectional associations between child sleep problems and internalizing and externalizing difficulties from preschool to early adolescence. *JAMA Pediatrics*, 172, e174363. [PubMed: 29204659]
- Reynaud E, Forhan A, Heude B, Charles M-A, Plancoulaine S, Annesi-Maesano I, ... & Dargent-Molina, P (2018). Night-waking and behavior in preschoolers: A developmental trajectory approach. *Sleep Medicine*, 43, 90–95. [PubMed: 29482820]
- Reynaud E, Forhan A, Heude B, de Lauzon-Guillain B, Charles MA, & Plancoulaine S (2016). Night-waking trajectories and associated factors in French preschoolers from the EDEN birth-cohort. *Sleep Medicine*, 27–28, 59–65.
- Rock D, & Pollack J (2002). *Early Childhood Longitudinal Study—Kindergarten Class of 1998–1999 (ECLS-K) Psychometric Report for Kindergarten through First Grade*. Retrieved from Washington, DC.
- Sadeh A, Mindell JA, Luedtke K, & Wiegand B (2009). Sleep and sleep ecology in the first 3 years: A web-based study. *Journal of Sleep Research*, 18, 60–73. [PubMed: 19021850]
- Sadeh A, Mindell J, & Rivera L (2011). "My child has a sleep problem": A cross-cultural comparison of parental definitions. *Sleep Medicine*, 12, 478–482. [PubMed: 21478050]
- Sivertsen B, Harvey AG, Reichborn-Kjennerud T, Torgersen L, Ystrom E, & Hysing M (2015). Later emotional and behavioral problems associated with sleep problems in toddlers: a longitudinal study. *JAMA Pediatrics*, 169, 575–582. [PubMed: 25867179]
- Smithson L, Baird T, Tamana SK, Lau A, Mariasine J, Chikuma J, ... & Turvey SE, (2018). Shorter sleep duration is associated with reduced cognitive development at two years of age. *Sleep Medicine*, 48, 131–139. [PubMed: 29906629]
- Soloff C, Lawrence D, & Johnstone R (2005). *Longitudinal Study of Australian Children Technical Paper No. 1: Sample Design*. Melbourne, Vic.: Australian Institute of Family Studies.
- Stone LL, Otten R, Engels RC, Vermulst AA, & Janssens JM (2010). Psychometric properties of the parent and teacher versions of the strengths and difficulties questionnaire for 4-to 12-year-olds: a review. *Clinical Child and Family Psychology Review*, 13, 254–274. [PubMed: 20589428]
- Tasca GA, & Gallop R (2009). Multilevel modeling of longitudinal data for psychotherapy researchers: I. The BASICS. *Psychotherapy Research*, 19, 429–437. [PubMed: 19235088]
- Tietze AL, Blankenburg M, Hechler T, Michel E, Koh M, Schluter B, & Zernikow B (2012). Sleep disturbances in children with multiple disabilities. *Sleep Medicine Reviews*, 16, 117–127. [PubMed: 21620745]
- Touchette É, Petit D, Séguin JR, Boivin M, Tremblay RE, & Montplaisir JY (2007). Associations between sleep duration patterns and behavioral/cognitive functioning at school entry. *Sleep*, 30, 1213–1219. [PubMed: 17910393]

- Author Manuscript
- Author Manuscript
- Author Manuscript
- Author Manuscript
- Van Dyk T, Becker SP, & Byars KC (2019). Mental health diagnoses and symptoms in preschool and school age youth presenting to insomnia evaluation: Prevalence and associations with sleep disruption. *Behavioral Sleep Medicine*, 17, 790–803. [PubMed: 30260686]
- Van Dyk T, Thompson RW, & Nelson TD (2016). Daily bidirectional relationships between sleep and mental health symptoms in youth with emotional and behavioral problems. *Journal of Pediatric Psychology*, 41, 983–992. [PubMed: 27189691]
- Varni JW, Burwinkle TM, Seid M, & Skarr D (2003). The PedsQL™ 4.0 as a pediatric population health measure: feasibility, reliability, and validity. *Ambulatory Pediatrics*, 3, 329–341. [PubMed: 14616041]
- Varni JW, Limbers CA, & Burwinkle TM (2007). Impaired health-related quality of life in children and adolescents with chronic conditions: a comparative analysis of 10 disease clusters and 33 disease categories/severities utilizing the PedsQL 4.0 Generic Core Scales. *Health and Quality of Life Outcomes*, 5, 43. [PubMed: 17634123]
- Wang B, Isensee C, Becker A, Wong J, Eastwood PR, Huang R-C, Brüni LG (2016). Developmental trajectories of sleep problems from childhood to adolescence both predict and are predicted by emotional and behavioral problems. *Frontiers in Psychology*, 7, 1874. [PubMed: 27990129]
- Wechsler D (2003). *The Wechsler Intelligence Scale for Children—4th ed (WISV-IC)—Technical and Interpretive Manual*. Retrieved from San Antonio, TX.
- Williams KE, Berthelsen D, Walker S, & Nicholson JM (2017). A developmental cascade model of behavioral sleep problems and emotional and attentional self-regulation across early childhood. *Behavioral Sleep Medicine*, 15, 1–21. [PubMed: 26619760]
- Williams KE, Nicholson JM, Walker S, & Berthelsen D (2016). Early childhood profiles of sleep problems and self-regulation predict later school adjustment. *British Journal of Educational Psychology*, 86, 331–350. [PubMed: 26918668]
- Williamson AA, Mindell JA, Hiscock H, & Quach J (2019a). Child sleep behaviors and sleep problems from infancy to school-age. *Sleep Medicine*, 63, 5–8. [PubMed: 31600659]
- Williamson AA, Mindell JA, Hiscock H, & Quach J (2019b). Sleep problem trajectories and cumulative socioecological risks: Birth to school-age. *Journal of Pediatrics*, 215, 229–237. e224. [PubMed: 31564429]
- Wissow LS, Brown J, Fothergill KE, Gadowski A, Hacker K, Salmon P, & Zerkowicz R (2013). Universal mental health screening in pediatric primary care: A systematic review. *Journal of the American Academy of Child and Adolescent Psychiatry*, 52, 1134–1147. e23. [PubMed: 24157388]

Key points

- Behaviourally based paediatric sleep problems are associated with poor outcomes.
- This study examined whether distinct sleep problem trajectories from infancy to middle childhood were linked to multiple aspects of child well-being.
- While all sleep problem trajectories were associated with increased psychopathology symptoms and worse quality of life, children with persistent sleep problems from infancy to school age had the worst middle childhood outcomes across well-being domains.
- Findings underscore the importance of early intervention for sleep problems and the need to integrate behavioural sleep treatment with other behavioural health services.

Figure 1.
Sleep problem trajectories from ages 0–1 to 10–11 years (Williamson et al., 2019b),
reprinted with permission from Elsevier Inc

Figure 2. Longitudinal sleep problem trajectories and psychosocial outcomes at ages 10–11 years. Abbreviations: PedsQL, Pediatric Quality of Life; SDQ, Strengths and Difficulties Questionnaire; SSIS, Social Skills Improvement System

Figure 3. Longitudinal sleep problem trajectories and cognitive and academic outcomes at ages 10–11 years. Abbreviations: ARS, Academic Rating Scale; NAPLAN, National Assessment Program—Literacy and Numeracy

Table 1

Participant demographic characteristics at Wave 1 (ages 0–1 years)

Child	<i>N</i> = 5,107
Male, %	51.1
Age (months), mean (<i>SD</i>); range	8.8 (2.5); 3–19
Primary caregiver	<i>N</i> = 5,107
Female, %	96.1
Age (years), mean (<i>SD</i>); range	31.0 (5.5); 15–63
Born in Australia/New Zealand, %	81.4
English main language spoken at home, %	85.6
Education status, %	
Did not complete high school	31.7
Completed high school only	35.5
Completed tertiary/postgraduate degree	32.9
Married/de facto, %	90.6
Family risk index, mean (<i>SD</i>)	0.27 (0.31)
Secondary caregiver	<i>N</i> = 4,629
Male, %	98.3
Age (years), mean (<i>SD</i>); range	33.7 (6.0); 16–65
Born in Australia/New Zealand, %	79.4
Education status, %	
Did not complete high school	40.2
Completed high school only	23.1
Completed tertiary/postgraduate degree	36.7
Family risk index, mean (<i>SD</i>)	0.28 (0.33)